REQUIREMENT UNDER 37 C.F.R. 1.121

As required under 37 C.F.R. 1.121, a clean version of the first paragraph of Page 1 is as follows:

This is a Continuation of copending Application No. 09/990,585 filed November 21, 2001 which is a Continuation-in-Part of: copending Application Serial No. 09/999,687 filed October 31, 2001; copending Application Serial No. 09/954,477 filed September 17, 2001; copending Application Serial No. 09/883,130 filed June 15, 2001, which is a Continuation-in-Part of Application Serial No. 09/781,665 filed February 12, 2001; copending Application Serial No. 09/780,027 filed February 9, 2001; copending Application Serial No. 09/721,885 filed November 24, 2000; Application Serial No. 09/327,756 filed June 7, 1999; and International Application Serial No. PCT/US00/15624 filed June 7, 2000, published as WIPO WO 00/75856 A1; each said application being commonly owned by Assignee, Metrologic Instruments, Inc., of Blackwood, New Jersey, and incorporated herein by reference as if fully set forth herein in its entirety.

Also required under 37 C.F.R. 1.121, a clean set of the amended Claims is provided herebelow:

670. A method of automatically producing digital images of a moving object, with pixels having a substantially uniform white level independent of the velocity of the moving object, said method comprising the steps of:

a) determining the velocity of an object moving relative to a planar light illumination and imaging (PLIIM) based imaging system having

a linear image detection array with a field of view (FOV) projectable onto the moving object,

a planar light illumination array (PLIA) with a plurality of light emitting diodes (LEDs) arranged in a linear array, for producing a planar light illumination beam (PLIB) coplanar with the FOV of said linear image detection array,

and

a micro-controller for controlling the operation of the PLIIM based imaging system;

b) using the detected velocity determined in step (a) to compute the optical power which each said light emitting diode (LED) must produce in order that each digital image of the object, formed by illuminating said object with said computed optical power, will have pixels with substantially uniform white level independent of the velocity of said object moving relative to said PLIIM-based imaging system;

c) transmitting the computed optical power value(s) to said micro-controller; and

d) said micro-controller using said computed optical power value to drive each said light diode so that it produces a planar light illumination beam (PLIB) having the computed optical power level with said FOV,

whereby the PLIB illuminates said object as said object moves through said FOV, and said PLIIM-based imaging system automatically produces a digital image of the moving object, with pixels having a substantially uniform white level, independent of the velocity of the moving object.

671. The method of claim 670, wherein step (a) comprises illuminating said object with a pair of amplitude-modulated (AM) laser beams, capturing a pair of images of said moving object, and processing said pair of images so as to compute the velocity of said object.

672. The method of claim 671, wherein step (b) comprises computing said optical power of said light emitting diodes (LEDs) by:

a) computing the line rate of the linear image detection array based on the computed object velocity and the constant image resolution desired;

b) computing the photo-integration time period of the linear image detection array based on the computed line rate; and

c) computing the optical power of each light diode based on the computed photo-integration time period.

673. The method of claim 670, wherein step (a) comprises detecting the velocity of the object transported relative to said PLIIM based imaging system supported above a conveyor belt structure, along which the object is being transported.

674. The method of claim 670, wherein step (a) comprises detecting the velocity of the object transported relative to said PLIIM based imaging system embodied within a hand-supportable housing, past which the object is being transported.

675. A planar light illumination and imaging (PLIIM) based system for producing digital images of a moving object, with pixels having a substantially uniform white level, said PLIIM based system comprising:

a system housing of unitary construction having a first light transmission aperture and a second light transmission aperture, wherein said first and second light transmission apertures are spatially aligned with each other;

a linear PLIIM-based imaging subsystem mounted within said system housing and having

a planar light illumination array (PLIA) including a plurality of light emitting diodes (LEDs) for producing and projecting a planar light illumination beam (PLIB) through said first light transmission aperture, so as to illuminate an object as it is moving past said PLIIM based system, and

an image formation and detection (IFD) module having a linear image detection array and imaging forming optics for providing said linear image detection array with a field of view (FOV) which is projected through said second light transmission aperture, and along which images of illuminated portions of said object can be detected,

wherein said PLIB and FOV are arranged in a coplanar relationship along the working range of said PLIIM based system so that the PLIB illuminates primarily within said FOV of the IFD module;

an object velocity measurement subsystem for projecting and scanning a light beam along the surface of said object, receiving light reflected from said object, generating electrical signals

representative to a characteristics of said received light, processing said electrical signals to determine the velocity thereof and generating object velocity data indicative of the determined velocity of the object;

a camera control computer, mounted within said system housing, for controlling the operation of said linear PLIIM-based imaging subsystem, in response to control data generated by said object velocity measurement subsystem and transmitted to said camera control computer,

wherein said camera control computer

(1) uses said object velocity data to compute the optical power which each light emitting diode (LED) in said linear PLIIM-based imaging system must produce in order that each digital image captured by said PLIIM system will have pixels with a substantially uniform white level, independent of object velocity; and

(2) generates and transmits control signals to said light emitting diodes (LEDs) in order to control the operation thereof so that said PLIIM-based imaging subsystem produces digital images of said object, wherein the pixels in each said digital image have a substantially uniform white level independent of the measured object velocity.

676. The PLIIM based system of claim 675, wherein said PLIIM based imaging is system supported above a conveyor belt structure, along which the object is being transported.

677. The PLIIM based system of claim 675, wherein said PLIIM based imaging system is embodied within a hand-supportable housing, past which the object is being transported.

678. A planar light illumination and imaging (PLIIM) system for producing digital images of a moving object, with pixels having a substantially uniform white level, said PLIIM based system comprising:

a system housing of unitary construction having a first light transmission aperture, a second light transmission aperture, and a third light transmission aperture, wherein said first and second light transmission apertures are spatially aligned with each other, and said third light transmission aperture is disposed at a predetermined distance away from said first and second light transmission apertures;

a linear PLIIM-based imaging subsystem mounted within said system housing and having

a planar light illumination array (PLIA) including a plurality of light emitting diodes (LEDs) for producing and projecting a planar light illumination beam (PLIB) through said first light transmission aperture, so as to illuminate an object as it is moving past said PLIIM based imaging system, and

an image formation and detection (IFD) module having a linear image detection array and imaging forming optics for providing said linear image detection array with a field of view (FOV) which is projected through said second light transmission aperture, and along which images of illuminated portions of said object can be detected,

wherein said PLIB and FOV are arranged in a coplanar relationship along the working range of said PLIIM system so that the PLIB illuminates primarily within said FOV of the IFD module;

a light scanning object velocity measurement subsystem mounted within said system housing, for producing a pair of amplitude modulated (AM) laser scanning beams which are projected through said third light transmission aperture so as to scan the surface of said transported object and determine the velocity thereof and generate object velocity data indicative of the determined velocity of the object;

a camera control computer, mounted within said system housing, for controlling the operation of said linear PLIIM-based imaging subsystem, in response to control data generated by said light scanning object velocity measurement subsystem and transmitted to said camera control computer,

wherein said camera control computer

(1) uses said object velocity data to compute the optical power which each light emitting diode (LED) in said linear PLIIM-based imaging system must produce in order that each digital image captured by said PLIIM based imaging system will have substantially the same white level, independent of object velocity; and

(2) generates and transmits control signals to said light emitting diodes (LEDs) in order to control the operation thereof so that said PLIIM-based imaging subsystem produces digital images of said object, wherein the pixels in each said digital image have a substantially uniform white level independent of the measured object velocity.

679. The PLIIM based system of claim 675, wherein said PLIIM based imaging is system supported above a conveyor belt structure, along which the object is being transported.

680. The PLIIM based system of claim 675, wherein said PLIIM based imaging system is embodied within a hand-supportable housing, past which the object is being transported.

681. A planar light illumination and imaging (PLIIM) based imaging system for automatically producing digital images of a moving object with pixels having a substantially uniform white

level independent of the velocity of the moving object, said PLIIM based imaging system comprising:

a linear image detection array with a field of view (FOV) projectable onto the moving object;

a planar light illumination array (PLIA) with a plurality of light emitting diodes (LEDs) arranged in a linear array, for producing a planar light illumination beam (PLIB) coplanar with the FOV of said linear image detection array;

an object velocity measurement subsystem for automatically measuring the velocity of the moving object;

a micro-controller for controlling the operation of the linear image detection array and said PLIA, and carrying out the following control operations:

(1) using the velocity of the object measured by said object velocity measurement subsystem, to compute the optical power which each said light emitting diode (LED) must produce in order that each digital image of the object, formed by illuminating said object with said computed optical power, will have pixels with substantially uniform white level independent of the velocity of said object moving relative to said PLIIM-based imaging system; and

(2) using said computed optical power value to drive each said light emitting diode (LED) so that it produces a planar light illumination beam (PLIB) having the computed optical power level with said FOV,

whereby the PLIB illuminates said object as said object moves through said FOV, and said PLIIM-based imaging system automatically produces a digital image of the moving object, with pixels having a substantially uniform white level, independent of the velocity of the moving object.

682. The PLIIM based imaging system of claim 681, wherein said PLIIM based imaging system is supported above a conveyor belt structure, along which the object is being transported.

683. The PLIIM based imaging system of claim 681, wherein said PLIIM based imaging system is embodied within a hand-supportable housing, past which the object is being transported.

As also required under 37 C.F.R. 1.121, a clean version of the amended Abstract is set forth herebelow:

ABSTRACT OF INVENTION

A method of and apparatus for automatically producing digital images of an object having a substantially uniform white level independent of the velocity of the object. The method comprising determining the velocity of an object moving relative to a planar light illumination and imaging (PLIIM) based imaging system having a linear image detection array with a field of view (FOV), a planar light illumination array (PLIA) with a plurality of light emitting diodes (LEDs) arranged in a linear array for producing a planar light illumination beam (PLIB) coplanar with the FOV, and a micro-controller for controlling the operation of the PLIIM based imaging system. The determined velocity is used to compute the optical power which each light emitting diode (LED) must produce in order that each digital image of the object, formed by illuminating the object with the computed optical power, will have substantially the same white intensity level independent of the velocity of the object relative to the PLIIM-based imaging system. The computed optical power value(s) are transmitted to the micro-controller, and the micro-controller uses the computed optical power value(s) to drive each light emitting diode so that it produces a planar light illumination beam having the computed optical power level with the FOV. By virtue of the present invention, the planar light illumination beam illuminates the object, and the PLIIM-based imaging system automatically produces a digital image of the moving object, with pixels having a substantially uniform white level, independent of the velocity of the object. Such image characteristics enables simpler and more reliable image processing in applications such as, for example, optical character recognition (OCR) processing, where image pixels having a substantially uniform white level, and a uniform aspect-ratio, are often desired or required.

REMARKS

The Commissioner is authorized to charge any fee deficiencies to Deposit Account No. 16-1340. A duplicate of this document is enclosed herewith.

Respectfully submitted,

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CERTIFICATE OF EXPRESS MAIL UNDER 37 C.F.R. 1.10

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